

# NOAA TESTBED

## *news*

LINKING RESEARCH & OPERATIONS TO IMPROVE WEATHER FORECASTS FOR THE NATION

## What's *news* at NOAA Testbeds

Welcome to the first edition of the *NOAA Testbed news*. Our aim is to convey just how much is going on in the NOAA Testbeds, especially those sponsored by, or created by the U.S. Weather Research Program (USWRP). We'll report on what the NOAA Testbeds are up to and give you a flavor of the many people, places and teams that make up the USWRP-related testbed community today. In each edition we'll have features on current scientific results, field program updates, project information, details on testbed related meetings, and a publications round-up. In this kick-off edition, our feature is from the Societal Impacts Program (SIP) and their new findings from their recent article, '300 Billion

Served: Sources, perceptions, uses, and values of weather forecasts,' which appears in BAMS this year. Another highlight is the summary of our first-ever NOAA Testbed Workshop held in Boulder, CO on April 28-29, 2009.

Our hope is to build new connections through a more informed Testbed and related USWRP community and connect with our partners. We look forward to hearing your thoughts, learning more about the testbeds together through this endeavor, and growing our efforts as we go. The newsletter is brought to you by NOAA's USWRP Executive Committee (NUEC); Marty Ralph (Lead), Al Powell (NESDIS), Don Berchhoff (NWS), and

*cont. on p.2*

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## A New Leader for WRF's Testbed

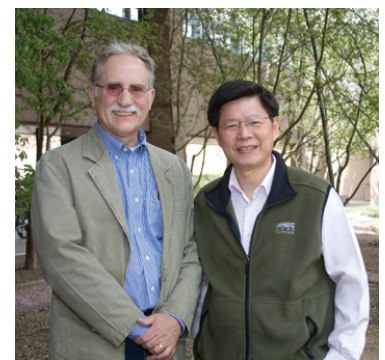
The new head of the Boulder-based Developmental Testbed Center knows quite a bit about WRF. In fact, he helped create it. Ying-Hwa "Bill" Kuo, who's been at NCAR since 1982, took the reins of the DTC on 1 April after the retirement of founding DTC director Robert Gall. NOAA's Steven Koch will continue as deputy director of the DTC.

Kuo and Gall were inspired to help develop what became WRF in 1996 after a program reviewer asked them about the impact of NCAR's community modeling on operational numerical weather prediction. "Bob [Gall] looked at me, and we said, 'It's close to zero.' But we agreed that NCAR's work should benefit society." Shortly afterward, Kuo and Gall met with Geoff DiMego (NOAA National Centers for Environmental Prediction, or NCEP) to lay the groundwork for the multiagency collaboration that led to WRF.

The twin missions of prediction and research are tightly linked at

the DTC, which was championed by Gall, Koch, and WRF program coordinator Nelson Seaman (Pennsylvania State University). The emphasis is on rigorous, quantifiable results, says Kuo: "We've focused on being a neutral party in testing and evaluation."

Since 2006, the DTC's Modeling Evaluation Tools (MET) package has provided a wide variety of techniques for verifying the skill of forecast models. The latest version—MET 2.0, released in April—includes new tools for verifying probabilistic forecasts, producing



Steven Koch and Bill Kuo. (Photo by Carlye Calvin.)

*cont. on p.5*

# Quick Response Science

After wildfires scorched more than 150,000 acres of mountainous terrain near Big Sur, CA last summer, USGS scientists surveyed the damage and discovered a significant risk of major debris flows. Even a moderate rainstorm could get soil, rock, and vegetation moving down of drainage basins.

Weather forecasters already knew that operational radar coverage in the area was inadequate for detecting low altitude rain clouds. Given the high risk—and a recent history of debris flows in fire-scorched areas of Southern California—the National Weather Service asked for ESRL/HMT help.

It was late September when David Reynolds, the Meteorologist-In-Charge at the NWS's San Francisco/Monterey Weather Forecast Office, made the request. By the end of October, Marty Ralph, Allen White (ESRL), and colleagues had state-of-the-art weather probing instruments up and running at Point Sur. These capabilities were developed and available as part of HMT and a joint NOAA-USGS plan for debris flows. The goal: Give weather forecasters the added information they need to get out earlier warnings when rain threatens the vulnerable burn area. Shallow rain clouds form when moist air off the Pacific Ocean flows up coastal mountain slopes. These clouds consistently elude the Weather Service's operational radar.

Nov. 1, a bank of these shallow clouds began to drop rain along the coast near Big Sur, invisible to the closest NWS NEXRAD radar, in Monterey. The shallow rain echo was clearly observed by the new Pt. Sur S-band radar, which had been operating for just a couple of days.

"As soon as we hit the first hour of rain falling at a rate of 0.6 inches an hour, the debris was coming down the hill," as the USGS study predicted, Reynolds said. Rocks, mud, and tree trunks roared down two drainages, he said. One of the flows filled a house with a couple feet of mud and continued on into the local Grange Hall, forcing election officials to find another polling site.

The S-band radar saw the rain essentially as it was falling, precluding officials from issuing a warning, but another tool available now at Pt. Sur—a suite of instruments developed by ESRL scientists combining measured winds aloft with integrated water vapor provided by a GPS receiver—should allow a short-term prediction of rainfall potential. "It might just give us the lead time we need for saving lives," Reynolds said.

—Excerpted from NOAA/ESRL Quarterly  
Winter 2008 Issue

*What's news, cont. from p.1*

Bob Atlas (OAR). Please visit the newly revamped website as well, [www.uswrp.org](http://www.uswrp.org) for more testbed and USWRP information, presentations from the Testbed Workshop, testbed links, and a complete list of publications.

## Recent & Upcoming Events

**1st NOAA Testbed USWRP Workshop**, April 28–29, 2009, Boulder, CO, Contact: Janet Intrieri (Janet.Intrieri@noaa.gov), website: <http://www.esrl.noaa.gov/research/uswrp/events/2009/workshop/agenda.html>.

**High Resolution Hurricane Workshop**, May 7-8, 2009, National Hurricane Center, Miami, FL, Contacts: Louisa Nance (nance@ucar.edu), Ligia Bernardet (Ligia.Bernardet@noaa.gov), website: [http://www.dtcenter.org/plots/hrh\\_test/workshop2009/](http://www.dtcenter.org/plots/hrh_test/workshop2009/).

**HMT Southeast Research Planning Workshop**, June 15-17, 2009, Chapel Hill, NC, Contact: Timothy Schneider (Timothy.Schneider@noaa.gov)

**WRF Tutorial**, July 13-24, 2009, NCAR, Boulder, CO, website: [http://www.mmm.ucar.edu/events/tutorial\\_709/index.php](http://www.mmm.ucar.edu/events/tutorial_709/index.php).

**Summer 2009 Weather and Society \* Integrated Studies (WAS\*IS) Workshop**, August 6-14, 2009, Boulder, CO, contact: Julie Demuth (jdemuth@ucar.edu), web site: <http://www.sip.ucar.edu/wasis/> (click on "Summer 2009" links on left).

**Workshop on Assessment of Socio-economic Benefits of Weather, Climate and Water Services**, September 21-25, 2009, Nanjing China, WMO Organized workshop on the use of economic analysis by National Hydro-Meteorological Services that will be facilitated by SIP staff.

**DTC Verification Workshop**, August 26-28, 2009, NCAR, Boulder, CO, Contacts: Tressa Fowler (tressa@ucar.edu), website: <http://www.ral.ucar.edu/research/verification/dtcworkshop2009/>.

**National Workshop on Mesoscale Probabilistic Prediction**, September 23-24, 2009, NCAR, Boulder, CO, Contacts: Bill Kuo (kuo@ucar.edu), Cliff Mass (cliff@atmos.washington.edu).

## Did you know...

DTC has a Visitor Program that provides an opportunity for scientists to work with the DTC in testing new techniques, models, & model components for Numerical Weather Prediction (NWP). Successful applicants are offered up to one month of salary compensation, travel and per diem, and spend one month at the DTC or one of the operational centers. More info: <http://www.dtcenter.org/visitors/>

# 300 Billion Served: Sources, Perceptions, Uses, and Values of Weather Forecasts

Jeffrey K. Lazo, Rebecca E. Morss, and Julie L. Demuth, NCAR

*Every day, the U.S. weather enterprise collectively disseminates numerous weather forecasts to the U.S. public through various media. The meteorological community knows intuitively that these forecasts are useful and of significant benefit to the public. But apart from anecdotal evidence and vague notions, the community doesn't have a clear overall picture of how members of the public obtain, perceive, use, and value weather forecasts. To begin developing this knowledge empirically, we conducted a nationwide survey with more than 1,500 respondents to assess their:*

**Sources:** Where, when, and how often people obtain weather forecast information

**Perceptions:** How people judge and understand forecasts

**Uses:** How people use forecasts for activities and decision making

**Values:** What dollar value households place on currently available forecasts

## Methods and Results

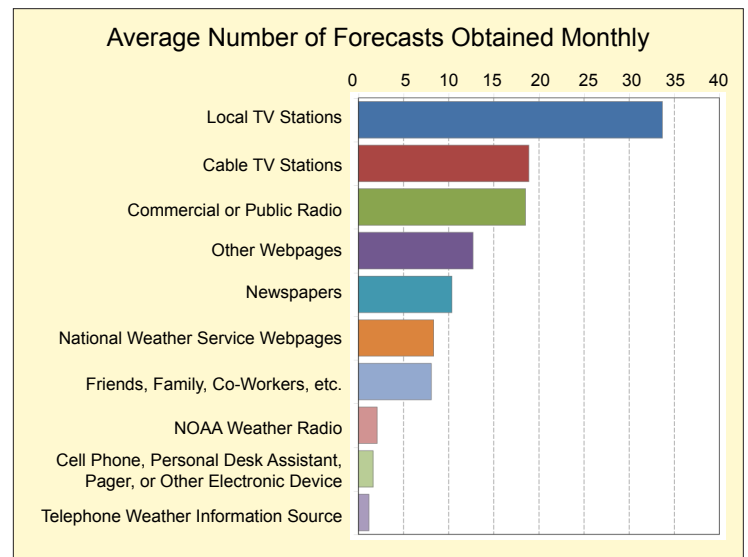
We followed state-of-the-art methods for developing and pretesting survey questions. Our initial draft survey was based on questions from a previous survey of households' values for weather forecasts. This draft was peer-reviewed and a revised survey was pretested with recruited non-meteorologists using one-on-one verbal protocols. We iteratively revised the survey content and structure based on these pretests. The survey was implemented online in November 2006. Because we could not assume that everyone uses weather forecasts, the first survey question defined a weather forecast and then asked respondents whether they ever use them. 96.4% of respondents said yes; the other 3.6% were not asked most of the rest of the survey questions.

### Sources

To assess respondents' sources, we asked them to indicate how often they obtain weather forecasts from each of 10 potential sources. Figure 1 shows the average number of forecasts obtained each month by source type. Respondents obtained forecasts from local TV stations—the most common source—33.7 times per month on average (a little over once a day). Cable TV and radio were the next most common sources, followed by web pages and newspapers. Across all sources, the average respondent obtains weather forecasts 115 times per month. With a U.S. adult population of nearly 226 million, and accounting for the 3.6% of respondents who don't use forecasts, this means an estimated 300 billion forecasts are obtained by U.S. adults each year.

### Values

We estimated forecast value following standard economics methodology for valuation of public goods. The survey question "offered" respondents a hypothetical amount that their household is currently paying in taxes for all NWS activities and asked if the services they are receiving are worth more than, worth exactly, or worth less than the amount indicated. Analysis of results extrapolated to a median fitted value of \$286 per household per year. With about 114,384,000 households in the U.S., and accounting for households who do not use forecasts, we estimate a total value of \$31.5 billion per year to U.S. households for all weather forecast services. With U.S. public and private sector meteorology costs totaling \$5.1 billion a year, we derive a net benefit of \$26.4 billion a year (\$31.5 billion in benefits minus \$5.1 billion in costs) and a benefit-cost ratio of 6.2 to 1.0 (\$31.5 billion in benefits to \$5.1 billion in costs).



## Conclusions

Before this study, little publicly available research had explored where, how often, or when people get weather forecast information across a range of contexts (i.e., not just for one weather event or for one provider's products) and how people perceive, use, and value this information. The basic understanding developed in this research highlights the importance of furthering this knowledge to develop a general picture of how the Weather Enterprise interacts with members of the public.

We advocate that assessments like ours should be performed regularly to understand how sources, perceptions, uses, and values are changing with time and to make sure that the knowledge on which weather forecasting decisions are based doesn't become outdated. This would allow for tracking of changes over time and provide indicators to policy makers of improvements or degradation of the value of forecasts and products from the end-user's perspective. For more detail, see Lazo et al. (forthcoming) and in Morss et al. 2008 (see below).

Lazo, J.K., R.E. Morss, and J.L. Demuth. 2009. "300 Billion Served: Sources, Perceptions, Uses, and Values of Weather Forecasts." *Bulletin of the American Meteorological Society*. 90(6):785-798.

*This work was funded in part by a grant from the National Science Foundation and by the USWRP.*



# Testbed Publications

Morss, R. E., J. Demuth, and J. K. Lazo, 2008: Communicating uncertainty in weather forecasts: A survey of the U.S. Public. *Weather & Forecasting*, 23, 974-991.

Morss, R. E., J. K. Lazo, B. G. Brown, H. E. Brooks, P. T. Ganderton, and B. N. Mills, 2008: Societal and economic research and applications for weather forecasts: Priorities for the North American THORPEX program. *Bull. Amer. Meteor. Soc.*, 89, 335-346.

Mainelli, M., M. DeMaria, L.K. Shay, and G. Goni, 2008: Application of Oceanic Heat Content Estimation to Operational Forecasting of Recent Atlantic Category 5 Hurricanes. *Weather & Forecasting*, 23, 3-16.

Sampson, C.R., J.A. Knaff, and M. De Maria, 2008: Experiments with a Simple Tropical Cyclone Intensity Consensus. *Weather & Forecasting*, 23, 304-312.

Bernardet, L., L. Nance, M. Demirtas, S. Koch, E. Szoke, T. Fowler, A. Lough, J. L. Mahoney, H.-Y. Chuang, M. Pyle, and R. Gall, 2008: The Developmental Testbed Center and its Winter Forecasting Experiment. *Bull. Amer. Meteor. Soc.*, 89, 611-627.

Neiman, P. J., F. M. Ralph, G. A. Wick, J. D. Lundquist and M. D. Dettinger, 2008: Meteorological characteristics and overland precipitation impacts of atmospheric rivers affecting the West Coast of North America based on eight years of SSM/I satellite observations. *J. Hydrometeor.*, 9, 22-47.

Lundquist, J. D., P. J. Neiman, B. Martner, A. B. White, D. J. Gottas, and F. M. Ralph, 2008: Rain versus snow in the Sierra Nevada, California: Comparing radar and surface observations of melting level. *J. Hydrometeor.*, 9, 194-211.

## Testbeds at a Glance

### Developmental Testbed Center

<http://www.dtcenter.org>

Begun in 2003 with support from USWRP and NCAR, the DTC's mission is to accelerate the improvement in weather forecasts by facilitating the transition of the most promising new NWP techniques from the research community into operations. The DTC, currently located jointly at NCAR and NOAA Earth Systems Research Laboratory, fulfills its mission by performing extensive retrospective tests of new capabilities in the Weather Research and Forecasting (WRF) community model, as well as supporting the addition of new capabilities to the WRF code base from the academic community through its visitor program. The DTC is currently in the process of expanding its community code support and testing to include the application of WRF to hurricanes and the Gridpoint Statistical Interpolation (GSI) data assimilation system.



### Hydrometeorology Testbed

<http://hmt.noaa.gov>

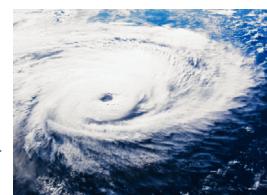
The HMT was established in 2003, partly as an effort to address a key focus of USWRP - to improve quantitative precipitation forecasting (QPF). HMT's aim is to accelerate the development & infusion of advanced hydrometeorological technologies, models, & scientific results from the research community to benefit daily forecasting operations of the NWS Weather Forecast Offices, River Forecast Centers & Hydrometeorological Prediction Center. HMT is an approach to meet those requirements through innovation, demonstration, & infusion. Major activities focus on QPF, QPE, snow information, hydrologic impacts, verification, & decision support tools. HMT's regional implementations include capabilities important nationally, & to individual NWS Regions. It is led by NOAA/ESRL's Physical Sciences Division with partners across NOAA Research & NWS, as well as universities and other agencies.



### Joint Hurricane Testbed

<http://www.nhc.noaa.gov/jht/index.shtml>

Begun in 2001 under the USWRP, the JHT is a competitive, peer-reviewed, granting process to choose the best mature research products for testing and transitioning to operations. The JHT includes modeling, data gathering, and decision support components. The testing is done at the Tropical Prediction Center. The current round of projects (4th) will undergo testing and evaluation during the 2009 hurricane season, with the projects nominally finishing 1 August (though testing of these may continue for the remainder of the 2009 season). Additionally, the next round (5th) of projects will begin 1 August, with testing and evaluation of these for the remainder of the hurricane season. The projects are usually two years in length.



### Societal Impacts Program

<http://www.sip.ucar.edu>

Mainly funded by the USWRP, with additional support from NCAR and NSF grants, this program is located at NCAR to address the societal impacts focus of the USWRP. The WAS\*IS component of the SIP is transitioning knowledge and processes to the NWS WFO's. Ongoing primary research focuses on lay people's use and understanding of uncertainty information in weather forecasts, the value of weather forecasts and the socio-economic impacts of extreme weather.



*...and there's more. Check the next edition for summaries of other testbed efforts including the Hazardous Weather Testbed, at NSSL/SPC and the Climate Testbed, at CPC.*

# Science to Ops: NOAA-wide Testbeds Workshop Draws Innovators, Operators

Nearly 70 weather and climate experts from around the country gathered at ESRL in April, for the first NOAA Testbed USWRP Workshop. In NOAA testbeds, researchers tackle serious, practical forecast challenges—improving flood forecasts in California, for example, or getting more lead-time on land-falling hurricanes. Testbed research involves innovative strategies that are not guaranteed to work, but serve society in powerful ways if they do, said Marty Ralph, chair of the U.S. Weather Research Program executive committee that organized and sponsored the Testbed Workshop.

“I’m excited to see this group here,” ESRL Director Alexander (“Sandy”) MacDonald said in a talk welcoming testbed workshop participants to Boulder. “We at the Earth System Research Laboratory are hell-bent to make all of our operational weather services the best,” MacDonald said. “Testbeds are a way to take what we have learned and get it into operations. Our job is to apply the science, so we provide the people of the United States with the best possible weather services.”

NOAA has been experimenting with testbeds for about a decade now, said Janet Intrieri, who coordinated the workshop.



Ralph, and John Gaynor (NOAA’s Office of Atmospheric Research) organized the workshop, ensuring that a wide variety of projects were represented, so participants could share best practices and potential pitfalls. Testbeds represented at the workshop included: Joint Hurricane Testbed, Hydrometeorology Testbed, Developmental Testbed Center, Societal Impacts Program, Collaborative Science, Technology, and Applied Research, Joint Center for Satellite Data Assimilation, Short-Term Prediction Research and Transition Center, Hazardous Weather Testbed, Climate Testbed, and the GOES-R Proving Ground.

Researchers involved in each testbed discussed recent and long-term achievements, and shared ideas for future work, especially collaborations. Diversity is part of what makes NOAA’s testbed program so strong, Ralph said. “It’s similar to ensemble forecasting. We all know that a diversity of models makes forecasts better,” he said. “A diversity of approaches in testbeds also leads to improvements.”

Among the attendees was Don Berchoff, the new Director of the Office of Science and Technology in the National Weather Service. “I found this extremely valuable,” Berchoff said after the workshop. “The testbed community needs to think about interoperability between the testbeds,” and the forum represented a start. Berchoff said that since the National Weather Service is laying plans to better incorporate uncertainty into forecasting, the social science presentations at the workshop were important for him to hear. “The briefings helped me to formulate a strategy and framework that I believe will help us focus our limited resources on what promises to deliver the biggest payback.”

—Excerpted from NOAA/ESRL Quarterly  
Summer 2009 Issue

## New Leader, cont. from p. 1

statistics on wind direction, and defining subdomains within models.

The DTC’s dedicated computing time allows for new code to be tested for as long as several months, helping ensure that it’s up to the rigors of day-to-day forecasting use. “Research scientists don’t always have the resources to carry out that many runs over an extended period. A new routine might work well for seven days, but on the eighth day, it might blow up,” says Kuo. Conversely, operational centers may not have the luxury of time needed for in-depth analysis of their modeling techniques.

The DTC’s two dozen staff are drawn mainly from NCAR’s Research Applications Laboratory and NOAA’s Earth System Research Laboratory (ESRL), with most holding joint appointments between the DTC and their home institutions. The center also maintains a visitor program and holds several workshops each year. Funding comes from NOAA, NSF/NCAR, and the Air Force Weather Agency.

Increasingly, the DTC is working on ways to entrain more data

into models. NCEP is using the center to help build an open-access version of one of its key data assimilation tools, the Gridpoint Statistical Interpolation scheme. The DTC will also offer a tutorial for NOAA’s Hurricane WRF model, which will be released to the community in the coming year as a coupled atmosphere/ocean system, eventually to include a wave model.

“I would say the DTC is one of the shining examples of NCAR and NOAA working together,” says Kuo. “Absolutely,” adds Koch. “All of the examples cited herein—the core WRF systematic testing procedures, the verification development and applications, support of the Hurricane WRF to the community—as well as others, have fully involved NCAR and ESRL’s Global Systems Division working closely together over the years.”

—Excerpted from the UCAR Quarterly  
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NOAA Testbed news is a publication from the NOAA USWRP Executive Committee, Dr. F.M. Ralph, Chair

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<http://www.uswrp.org>